UNITED STATES DEPARTMENT OF AGRICULTURE

SYLLABUS 25

Contribution from the States Relations Service
A. C. TRUE, Director
In cooperation with the Bureau of Plant Industry
W. A. TAYLOR, Chief

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ILLUSTRATED LECTURE ON LEGUMINOUS FORAGE CROPS FOR THE NORTH

By

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H. B. HENDRICK, Specialist in Agricultural Education States Relations Service

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SYLLABUS 25—ILLUSTRATED LECTURE ON LEGUMINOUS FORAGE CROPS FOR THE NORTH.[1]

By CHARLES V. PIPER, *Agrostologist in charge of Forage Crop Investigations, Bureau of Plant Industry,* and H. B. HENDRICK, *Specialist in Agricultural Education, States Relations Service.*

INTRODUCTION.

View.

From the earliest days of agriculture farmers have observed that the clovers, alfalfa, beans, and peas enriched the soil so that wheat, corn, cotton, and similar crops gave better yields following them than when planted after the grains or grasses. The reason for this benefit to the soil, however, is of recent discovery and the broader practical application of the knowledge is just beginning to be made effective.

The subject matter of this lecture applies especially to that part of the United States north of the southern boundary of profitable timothy hay production. The lecture does not apply accurately to conditions in the far Northwest, although that region produces considerable timothy. 1

DISTINGUISHING CHARACTERISTICS OF LEGUMINOUS PLANTS.

Leguminous plants are readily distinguished, in most instances, by the characteristic form of their flowers, of which the garden pea is typical, and by the seed-bearing pods which split upon ripening at both edges or sutures. The most

[1] This syllabus has been prepared in direct cooperation between the Office of Forage Crop Investigations of the Bureau of Plant Industry, as regards subject matter, and J. M. Stedman, Farmers' Institute Specialist, of the States Relations Service, as regards pedagogical form. It is designed to aid farmers' institute and other extension lecturers in presenting the subject before popular audiences. The syllabus is illustrated with 45 lantern slides. The numbers in the margins of the pages refer to the lantern slides as listed in the Appendix.

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View.

important difference, however, between leguminous and non-leguminous crop plants as they affect the fertility of soil is the formation of nodules or tubercles, which are normally attached to the roots of thriving plants of the legume family. These nodules vary greatly in size and shape. On the roots of red clover they are about the size of a pinhead and ovoid in form; on alfalfa they are somewhat larger and irregular in shape, frequently forming egg-shaped masses the aggregate of which may be the size of a very small marble; while on soy beans the nodules resemble the seeds of the common pea both in size and shape. For many years and until comparatively recent times these nodules were thought to be a form of root gall disease. In 1886 the scientists Hellriegel and Wilfarth discovered their real function in relation to the plants and to the soil.

FUNCTION OF ROOT NODULES AND NODULE BACTERIA.

If a nodule on a living plant be cut open and some of the juicy substance in it be spread thinly upon a glass slide, examination under a high-power microscope will reveal an immense number of living single-celled organisms of the kind called bacteria. These nodule-forming bacteria, when in the soil, pass into the minute root hairs of leguminous plants during their early growth and establish themselves in the outer layer of cells of the true roots, where they multiply rapidly and form the enlargements called nodules. The relation of nodule bacteria to the host plant is symbiotic; that is, the two are mutually helpful. The plant furnishes a home for the bacteria, and the bacteria, in turn, manufacture food for the plant.

Plants, like animals, require food materials for growth. Among the most important plant foods are compounds of the element nitrogen, which as an invisible gas comprises about four-fifths of the atmosphere. Nitrogen can not be utilized as a food in the leaves of plants, as carbon dioxid is utilized, but must first be combined with other elements to form soluble compounds which can be absorbed readily by the roots. The nodule bacteria of leguminous plants use nitrogen directly from the air as it circulates in the soil and convert it into nitrogenous compounds which are utilized in the growth of the plants.

Nonleguminous crops, including corn, other grains, and the grasses, secure all of the nitrogen for their growth from the soil. All leguminous crops under normal conditions obtain a

View.

large part of their nitrogen through bacterial action directly from the air, and in general they contain a larger percentage of nitrogen and consequently make richer feeds than non- 6
legumes.

INOCULATION.

When a leguminous crop that has not been grown in a field is planted for the first time, nodule-forming bacteria of the right kind probably will not be in the soil and should be supplied. If not supplied, only a few nodules are apt to develop, in which case the plants must secure nearly the entire 7
supply of nitrogen for growth from the soil. Furnishing bacteria to the soil for utilization by legumes is called *inoculation*.

SOIL-TRANSFER METHOD.

A practical and effective method of introducing inoculation is to transport soil from a field containing the bacteria needed. Soil from fields of alfalfa, sweet clover, and bur clover is interchangeable as regards inoculation; likewise from red, alsike, crimson, and white clovers; also from fields of the vetches and field peas. In the case of cowpeas and soy beans, however, each requires its particular strain of bac- 8
teria for inoculation. Soil for inoculation should be free from obnoxious weeds. It should be taken from the first 5 or 6 inches of the surface and spread at the rate of 200 to 400 pounds per acre on the field to be sown. Nodule bacteria are killed by much strong sunlight, so the inoculating soil should be spread during cloudiness, early morning, or late afternoon and harrowed in soon after.

SOIL-COATING METHOD.

Where inoculating soil is scarce, economy may be practiced by making a thin mixture of chip glue and water, sprinkling this over the seed to be sown at the rate of about a quart of the liquid to a bushel of seed, then mixing enough of dry, inoculated soil with the seed to make it sufficiently dry to sow well. The inoculated soil thus becomes coated over the surface of the seed and is carried into the soil with the seed.

LIQUID-CULTURE METHOD.

Another common, very convenient, and generally satisfactory way of inoculating soil is by means of the bacterial liquid 9
cultures, a limited supply of which may be secured free upon application to the United States Department of Agriculture.

View.

Many of the State experiment stations sell these cultures at a price sufficient to cover cost of production, and liquid cultures are also sold by commercial firms. Directions for the use of the cultures accompany all shipments of this material.

THE RELATION OF LEGUMES TO CROPPING SYSTEMS.

Leguminous plants, because of their relation to nitrogen-fixing bacteria, are called nitrogen gatherers. If leguminous crops are not grown frequently as a part of the cropping system of a farm the nitrogen supply of the soil is apt to become depleted, especially where nitrogenous fertilizers are not purchased and freely used. The latter way of keeping up the nitrogen is expensive and is seldom profitable except for truck
10 gardening or other intensive farming. The safer and more practical way in most instances is to maintain the supply of nitrogen by growing legumes, which, besides furnishing nitrogen, keep up the needed humus supply in the soil. Every second to fourth crop in the rotation should be leguminous, depending upon whether the soil is generally fertile and whether the crops of the farm are chiefly sold or fed, and in the latter case whether the manure produced is carefully preserved and returned to the soil.

The place which leguminous crops should occupy in any cropping system must depend upon the crops of the rotation, length of the growing season, and the legumes grown. The best returns are realized, as a rule, by following legumes with
11 strong-growing cultivated crops such as corn, grain, potatoes, or tobacco. Winter grain crops may well follow cowpeas or soy beans, and the nitrogen which is fixed in the soil by the legumes is valuable to the early growth of these grain crops.

From the farming standpoint leguminous crops may be classified in three groups: (1) Warm-season annuals, which include soy beans and field peas; (2) cool-season annuals, such as crimson clover and hairy vetch; and (3) biennals and perennials, including alfalfa, sweet clover, alsike clover, red clover, and white clover. The purpose which the legume is to serve on the farm must determine from which group it should be selected.

COMMENDABLE CROPPING SYSTEMS.

CORN, OATS, WHEAT, "GRASS" ROTATION.

The standard rotation most used in general farming in the great timothy and clover belt of this country is corn, oats, wheat, grass. This rotation is modified to some extent

View.

to meet the conditions due to difference in latitude, kind of 12
soil, and type of farming, yet the general plan of the rotation commonly prevails. The crops follow each other, as a rule, in the order named.

Corn in this rotation is planted in late spring to early summer, after turning under a grass sod. Fall plowing of sod usually gives a better crop of corn than spring plowing. Oat seeding should be done early in spring, following corn harvest. The oat stubble should be turned under as soon as is convenient after harvesting the oat crop, and the soil is then prepared for wheat, which should be sown during September and October, depending upon the location. The grass in this rotation commonly consists of timothy, which is seeded in the fall with wheat, and red clover, which is sown early the following spring by being broadcasted during honeycomb freezes or by being put in with a small-seed disk drill as soon as the soil is dry enough to be worked. The seeding may be varied to meet local conditions by adding to the timothy-clover seed mixture redtop, orchard grass, alsike clover, and other forage plants. Mammoth clover may also be used to advantage in the place of red clover in some areas of the southern part of this section.

The proportion of clover in the timothy-clover mixture for the regular hay crop should be large for the good of the soil, 13
and the second growth may well be pastured and turned under for soil enrichment. When clover seed is harvested the clover straw should be returned to the ground which produced it and be plowed under.

In sections where either wheat or oats can not be produced with profit, or in good corn sections where wheat seeding interferes with the harvesting of corn or wheat harvest causes the cultivation of corn to be neglected, it is common practice to grow only one grain crop in the rotation, as corn, oats, grass or corn, wheat, grass. From the standpoint of the fertility of the soil such a rotation is better than the rotation including both grains, provided the grass is largely clover. With oats there may be some difficulty in securing the successful stand of clover, because the quick and heavy growth may smother the small clover plants.

In dairy sections either the three-crop or the four-crop rotation is commonly lengthened one or more years by extending the time the land is left in sod. In some localities the sod 14
is pastured the last year before plowing.

CORN, SOY BEANS, WHEAT, "GRASS" ROTATION.

View.

In much of the southern part of the timothy-clover section where oats can not be produced successfully for grain, and in some localities farther north, soy beans are substituted profit-
15 ably in the four-year rotation, as corn, soy beans, wheat, clover. This is a somewhat new, but a splendid rotation. The legumes grown every other year help to maintain a good supply of nitrogen in the soil, and the soy beans make a feed for dairy cattle, beef cattle, and sheep nearly equal to alfalfa. When the soy beans are cultivated, wheat can be sown following their harvest after simply harrowing the ground thoroughly. Whenever practicable a cover crop, preferably a legume, should follow the crop of corn.

Hairy vetch is a strong winter-growing legume. It can be sown in corn just before the last cultivation, but its use is re-
16 stricted because of the usual high price of seed. However, the increasing practice of home production of vetch seed is relieving this difficulty. Owing to its trailing habit, vetch seed is sown with rye, wheat, or barley to hold it up.

Crimson clover as a cover crop in corn is commendable
17 where it does well, and its use for this purpose is increasing.

Where dairying is the principal industry, or where many hogs are raised and fattened, it is often desirable to use the rotation corn, corn, grain, grass. For dairy cattle the grass should be largely clover, and soy beans may be more useful than a crop of oats or wheat.

When it is desired to introduce alfalfa into the cropping system, it may be sown upon any field of the farm where its requirements can be met. The alfalfa field may finally again be worked into regular rotation by planting it first to corn, which may be followed in regular order with the other crops of the rotation.

Many variations in the standard rotation for the timothy-clover section may be worked out to suit any special conditions relating to kinds of soil, type of farming, etc.

UTILIZATION OF LEGUMINOUS CROPS.

Unquestionably the best way to dispose of forage crops is to feed them to live stock. Legumes are rich in nitrogen com-
18 pounds, or protein, and furnish exceptionally good feeds for all kinds of live stock. Alfalfa hay is successfully substituted, in part, for such concentrates as wheat bran and cotton-seed meal for feeding both dairy and beef cattle. Soy-bean

hay is about equal in feeding value to alfalfa. While not equal to alfalfa for feeding, red clover, alsike clover, field peas, and sweet clover are all much more valuable for milk production or growing young stock than timothy, redtop, orchard grass, or other nonlegumes.

There should always be a good mixture of leguminous plants in every permanent pasture. This is essential in order that the stock pastured may give the best possible returns, and also that the fertility of the soil may be conserved. Some of the best legumes for pasture mixtures in the North are red clover, alsike clover, and white clover.

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From 75 to 90 per cent of the total fertilizing matter of feeds consumed by animals is voided in the manure. Manures produced from feeding leguminous crops, as heretofore stated, are richer in nitrogen and hence of greater fertilizing value than those resulting from nonleguminous feeds. However, it is necessary to apply manure promptly, avoiding all possible losses from leaching, fire-fanging, etc., in order that the soil may approximate the benefits possible from the freshly voided manure.

As has been shown, three distinct advantages result from the growing and proper utilization of leguminous crops: (1) They add nitrogen to the soil directly through bacterial action in the root nodules; (2) they furnish excellent feed for growing animals and for milk and beef production; and (3) they yield particularly rich manures when fed to live stock.

LEGUMES AS GREEN MANURES.

When for any reason enough live stock to provide the manure required to keep the soil well supplied with humus can not profitably be kept on the farm it is necessary to provide some crops to return to the soil as a substitute. Crops grown for this purpose are called green-manure crops. Legumes have a great advantage as green manures over other plants inasmuch as they increase the nitrogen of the soil in which they grow as well as supply humus. Perennial legumes root deeper than grains and grasses and so are more beneficial in loosening the soil. Where the system of farming and the soil are such as to make green manuring necessary it should be managed, if possible, so that one crop each year may be harvested and still leave opportunity for a green-manure crop. When red clover is one of the crops of the rotation, the second growth will often furnish a good green-manure crop to turn under.

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View.

A crop that is sown following the main crop of a season is called a catch crop. In the southern part of the Northern States early maturing crops such as the grains, early potatoes,
21 etc., are harvested in time to warrant following with a catch crop. Soy beans are perhaps the best legume catch crop for this section. If grain stubble be turned under and the ground well prepared for planting soon after harvest, soy beans may still be sown early enough to secure a good quantity of green manure. After digging an early crop of potatoes the soil may be prepared, without plowing, and sown to soy beans for soil enrichment.

A crop sown to occupy the ground during the interval between the growing of regular crops is called a cover crop.
22 A winter cover crop is of value (1) in taking up during its growth available plant food which otherwise might be leached from the soil and lost; (2) in protecting against erosion soils which ordinarily become badly washed from heavy fall and winter rains; and (3) in supplying good winter pasturage. Leguminous cover crops besides giving the above values add to the nitrogen in the soil. Cover crops should be turned under in the spring for green manure. The principal legumes used in the North for cover crops are red clover, crimson clover, and hairy vetch. It is a common practice to mix hairy vetch with rye for a winter cover crop.

When the system of farming or the condition of the soil is such as to make it desirable to devote one year in a rotation to soil improvement, selection may be made from a large number of legumes to use for green manures. Soy beans, red clover, alsike clover, and sweet clover are all good and should be chosen for this use according to special adaptation.

PRINCIPAL LEGUMINOUS CROPS FOR THE NORTH.

RED CLOVER.

Red clover is the most important leguminous forage crop of the timothy-clover area, including the New England, Middle
23 Atlantic, and North Central groups of States. It is also an important crop in certain sections of the great Northwest and in the northern part of the South Central States. Red clover fits admirably into the cropping systems of the North and Northeast and is well adapted either for a hay crop or for pasture. The stand is generally secured following grain with the expenditure of only a small amount of labor, and the crop leaves the soil in a comparatively high state of fertility to follow with corn, potatoes, or winter grain.

View.

In sections where it does well red clover may be considered as the basis for permanent systems of agriculture. Whether it be fed to live stock and the manure be unwastefully returned to the soil, or whether it be returned to the soil directly as a green manure, red clover increases the supply of nitrogen in the soil and keeps up the humus content. Experiments have shown that even though the hay crop be removed, from 30 to 50 per cent of the fertilizer value of red clover may be in the roots and stubble which are plowed under.

Red clover is best adapted to deep well-drained clay loams and limestone areas, although it grows well on a variety of soils. It is productive on sandy soils when well supplied with 24
humus. In general, it will not flourish on ill-drained land or soils which are sour or acid.

Mammoth, commonly called sapling, clover is a large late-maturing variety of the red. On this account it is sometimes used with timothy for hay, since the two mature at about the same time. Mammoth clover matures but one crop a year. The seeds of red and mammoth clovers are the same in appearance.

Red clover is commonly sown in the spring on winter grain, 25
which is called a nurse crop. This is a cheap and convenient way of seeding. The method, however, is often unsuccessful on soils low in humus content, in which case the surface of the ground dries out quickly after removing the grain and the clover perishes. When sown in winter grain, clover seed should be sown very early in spring, so that the seed will become covered from the honeycomb freezes. A modern
method of seeding is by the use of the small-seed disk drill, 26
which should be used in the spring as soon as it is dry enough so that the machine will not clog. The disk drill is a great saver of seed, and clover seeded with it sometimes seems to withstand dry weather following the grain harvest better than when broadcasted by the old method.

A generally successful way of seeding red clover, except in the more northerly portion of the clover belt, is to sow in late summer or early fall on a thoroughly prepared seed bed. To be well prepared the seed bed must be finely pulverized, thoroughly compacted, and comparatively free from obnoxious
weeds. Grain stubble, if plowed right after harvest, may be 27
prepared in time to sow to red clover. Seeding should be at the rate of from 8 to 12 pounds per acre of clover alone, or from 6 to 8 pounds per acre when seeded with timothy. The smaller of these amounts of good seed will be ample when the disk seeder is used. On heavy soils the seed should not be

View.

placed over one-half inch deep and not over 1 inch deep on light soils. On loose soil, rolling should follow the seeding, but the roller should, in turn, be followed by a light harrow or brush.

Clover for hay should be cut as soon as it is in full bloom. When the stalks are thoroughly wilted, and before the leaves have become dry and brittle, the hay should be raked into windrows for curing. It is still better to put the windrows
28 into cocks which will turn water somewhat and leave it in this condition until cured fit for hauling. It pays always to store clover hay under cover instead of stacking, as storms darken the hay to considerable depths in the stacks and seriously injure its feeding value.

Red clover is rich in protein, palatable, and of high feeding
29 value. It is relished by all classes of animals. It makes splendid pasture, but causes bloat to cattle and sheep which are turned upon it in early spring or following heavy dews. Pastures usually contain a good part of timothy or bluegrass, in which case the danger from bloat is practically eliminated.

The acreage in successful stands of red clover has materially decreased during the past 10 or 12 years. Among the causes commonly contributing to partial or total failures are: Low supply of humus in the soil; poor drainage; sour, or acid, soil; poor inoculation; or possibly plant diseases and toxins.

As the supply of humus in soil diminishes its moisture-holding power decreases. With depleted humus, the surface 2 or 3 inches of soil dries out very quickly after rains and heavy soils become hard and baked. Young clover is commonly grown with grains as a nurse crop. Grain is usually cut in fair weather, and a few days of sunshine without rain following the cutting often dries out the surface of soils deficient in humus so that the young clover plants wither and die for lack of moisture.

Red clover will not do best on poorly drained and sour, or acid, soil. In case wet lands can not be drained, or until the acid condition of sour soil can be overcome, alsike clover should be grown instead of red clover. Soil acidity on well-drained soils can be overcome by the application of about 1 ton of burned lime or about 2 tons of finely ground limestone per acre.

On land where red clover has not been grown for some years it is frequently necessary to inoculate the soil with the right kind of bacteria before success can be had, and in numerous instances failure to inoculate for this crop has resulted in failure to the red clover.

ALSIKE CLOVER.

View.

In manner of growth alsike clover is midway between red clover and white clover. It will do fairly well on some soils where red clover fails for need of lime. It also grows on some 30
soils which are too poorly drained for success with red clover. It is a good plant for use in mixed pastures, and under favorable conditions its growth is such as to produce fairly good yields for hay. The practice of mixing alsike clover seed with the red for a timothy-clover mixture is increasing. Probably 75 per cent of the timothy-clover meadows to-day contain some alsike. It helps to insure an even stand, doing well on wet and sour spots, which would not be occupied by the red clover. A common mixture is one-third alsike and two-thirds red clover seed.

SOY BEANS.

The soy bean is a comparatively new crop in this country, but one which has fast gained favor in the North and South alike. The soy bean withstands dry weather well and makes a hay 31
similar in quality to that of cowpeas and nearly equal in feeding value to alfalfa. It grows erect and holds its leaves well, but has a somewhat fibrous stem. Soy beans produce heavy yields, and the seeds are rich in feeding value. There are many different varieties which differ in time of ripening from 90 days from sowing to the entire growing season. The Mammoth Yellow is the most commonly grown late variety for hay, but ripens its seed only south of the Potomac and Ohio Rivers. The Ito San is one of the best of early varieties, while the Haberlandt, Wilson, Tokyo, Medium Yellow, and Barchet are popular in certain sections.

Soy beans are sown broadcast or drilled, but, being erect, are well suited to cultivation in rows. Rows should be placed 3 or 32
more feet apart, and the seeding should be from 1½ to 2 pecks per acre. This quantity of seed should, of course, be increased for broadcasting. The seed should be planted not deeper than 2 inches, and as this is still a new crop in many places, inoculation should be practiced. It is not well to plant soy beans near to woods, as rabbits are very fond of the plant.

If used for hay, soy beans should be cut when the first leaves begin to turn yellow; if for seed, the cutting should not be done until the leaves have nearly all fallen. The pods of many varieties shatter easily and should be harvested as soon 33
as ripe and in the morning when the plants are wet with dew.

Curing soy-bean hay during a rainy season is somewhat difficult, and for this reason planting should be done, if possible,

View.

sufficiently early for the soy beans to be ready to cut before the heavy fall rains of the north set in. The ordinary mower is the best machine for cutting. When the vines are thoroughly wilted they should be turned with a tedder or pitchfork and may then remain for 24 hours or so before being raked into windrows. The hay should then be put into cocks and remain there until it is sufficiently cured for hauling to stack or barn. When the weather is especially favorable the curing may be done in the windrows, thereby saving the labor of cocking. If it gets wet in the windrow it should be spread out to dry as soon as the water has dried from the surface.

34 A convenient device to use for drying soy-bean hay may be made with strips or poles 6 feet long joined at the top and held 4 feet apart at the bottom by means of crosspieces upon which the vines are piled. This permits the air to circulate freely among the vines, which cures them quickly and satisfactorily with little loss of leaves. The racks may be conveniently stored after using and will last for several seasons. Another device which accomplishes the purpose fairly well is made by nailing two crosspieces at right angles to each other near the bottom of a pole from 4 to 6 feet long which is driven into the ground.

COWPEAS.

Cowpeas are specially adapted to a warm climate and a long growing season, and so will not do as well as soy beans in

35 the States far to the north. The plants do not grow as erect nor hold their leaves as well as soy beans, but the stems are less fibrous and the plants make a hay of first-class quality which is relished by all farm animals. Cowpeas are fairly well adapted to all types of soil, when well drained, and are a valuable crop to plant with corn in the southern part of the Northern States, especially on the poorer corn soils. The corn holds up the vines, and the cowpeas, in turn, add to the nitrogen supply of the soil. The Whippoorwill and the New Era are early-maturing varieties and are among the best for this section of the country. Cowpeas are pastured or are cut and harvested for hay in the same manner as soy beans, but they are sappy and harder to cure than soy beans.

ALFALFA.

On land where it will succeed alfalfa is one of the best crops for a permanent meadow and is also valuable as a pas-

36 ture plant. Alfalfa needs rich, well-drained land having a permeable subsoil and containing a good supply of lime. In

general, the loams are better adapted to alfalfa than sandy soils and dry clay uplands. Wherever the soil is of limestone origin or contains a high percentage of lime, alfalfa is nearly sure to succeed.

Many soils not naturally adapted to alfalfa have been made suitable by special treatment, and the acreage of this crop is increasing very fast as a result of the utilization of such areas. Some wet lands become suited to alfalfa when thoroughly drained. Lands newly drained, and many other well-drained lands commonly need an application of lime for alfalfa. From 1 to 2 tons of burnt lime, 2 to 3 tons of slaked lime, or 3 or 4 tons of finely ground limestone per acre are good applications. A fertile soil, well drained and well limed, can generally be **37** made to produce alfalfa. Where the soil is not fertile it is always advisable to improve it by the use of barnyard manure or green manure before sowing to this crop.

The seed bed should be thoroughly prepared before sowing alfalfa seed: that is, it should be finely pulverized, well compacted, and free from weeds. Well-cultivated fields of early varieties of soy beans, early potatoes, or similar crops which mature early may be easily prepared for alfalfa, after harvesting these crops, without plowing the ground. A thorough **38** disking with sufficient harrowing and rolling will fit the soil for sowing. From 25 to 30 pounds of alfalfa seed per acre should be sown and lightly covered. Seeding, in the northern tier of States, should be done in spring or early summer. Farther southward late summer or early fall seeding is best, since it avoids the worst injury from crab grass, and other summer weeds may be avoided by sowing at this season. Fall seeding should always be done sufficiently early to permit a good growth before winter sets in.

In fields where alfalfa has not been grown for a few years inoculation should always be practiced.

Fall-sown alfalfa should yield from two to four cuttings the following season and average about 1 ton of cured hay per acre **39** each cutting. There is no better hay than alfalfa for dairy or beef cattle, sheep, and young growing stock of all kinds. It is also a valuable feed for working animals, but care should be taken not to feed it to them excessively. It affords splendid pasturage for hogs, but care must be taken not to pasture it too closely or too late in the season. In general, pasturing alfalfa in the North Central and Northeastern States is not to be recommended, as the stand is frequently injured, then weeds thrive and invade the field.

MELILOTUS.

View.

Melilotus, or sweet clover, grows luxuriantly in soil well supplied with lime. It is one of the greatest soil builders among leguminous plants. It grows vigorously on very thin land, if lime is present, and, if undisturbed, after being well seeded will restore barren and depleted soils to a state of productivity.

40 Melilotus is abundant in many places where the lime rock is only thinly covered with soil.

There are three varieties of melilotus, the biennial white, the biennial yellow, and the annual yellow. The last named is of little value in the North.

Melilotus generally should be sown in March and April at the rate of 20 pounds per acre of hulled or one-half bushel of unhulled seed. Both biennial varieties make a fairly good growth the first season, live through the winter, and mature seed the second season, after which the plant dies. After a

41 field is once thoroughly seeded, both the first and the second year's growths occupy the ground each season.

In some sections where melilotus is well established it is common to pasture it lightly until the second year's growth is approaching maturity, when the stock is removed and the crop is later cut as hay or allowed to mature as a seed crop.

42 When cut early, before the stems are hard and woody, melilotus hay is of good quality and valuable for feeding. The flavor of the plant, however, both green and cured, is such that animals will rarely eat it until trained to do so.

VETCHES.

Hairy vetch is a strong-growing annual winter legume which furnishes good winter pasture and hay. It also makes a good

43 mixture to use with rye for winter pasture. When used with rye, about 1 bushel of the grain and from 1 peck to a half bushel of vetch should be sown during late August or September. The seed of hairy vetch is generally expensive. When grown for the first time on a field the soil should be inoculated.

When pastured in winter, the stock should be removed from the vetch, or vetch mixture, fairly early in the spring, to permit growth for a good cutting of hay, or covering of green manure. If cut when mature, enough of the vetch seed will often shell and scatter to reseed the soil.

CRIMSON CLOVER.

View.

Crimson clover is a winter annual well adapted as a cover crop in many sections of mild winter climate. It is grown most abundantly in Delaware, New Jersey, and other coast States southward. Its extent has increased very fast in late years, and it is now grown in many States west of the Allegheny Mountains. 44

Crimson clover should be sown at the rate of 10 to 15 pounds per acre in August when the first good autumn rains set in. It is commonly sown in corn or other cultivated crops following the last cultivation either just before or just after a penetrating rain. Inoculation should be practiced on fields where the crop has not been grown previously.

Crimson clover furnishes late fall and winter pasture of good quality, and it is sometimes cut for hay in the spring. Its principal value, however, is to turn under for a green-manure crop.

FIELD PEAS.

Field peas are grown to a considerable extent in the northern part of the United States, largely for forage. They are, as a rule, either harvested for hay or pastured down by hogs and are a valuable feed for either purpose. They will grow on nearly all types of soil, but do best on rather heavy land when well drained. They are sown broadcast or drilled in in the same way as soy beans or cowpeas. From 1 bushel to 5 pecks per acre makes a good seeding.

As a forage crop field peas and oats are frequently sown together. The pea vines, which fall down and tangle very easily, climb up on the oat stalks and are thus held off the ground. About 3 pecks of oats and from 2 to 3 pecks of field peas per acre should be mixed together and sown from a grain drill or broadcasted. The hay mixture should be cut when the oat straw is still green and the grain is in the milk stage. Well-cured pea and oat hay is first-class for dairy cows and sheep and, in fact, feeds well to all farm animals. 45

APPENDIX.

LANTERN SLIDES.

No. of view.

1. Cotton and timothy sections map of the United States.
2. Characteristic blossoms and pods of legumes.
3. Nodules on soy-bean roots.
4. Cross section of nodule of lupine × 46. Bacteria from alfalfa nodule × 1,000.
5. Field of soy beans—plants which can get nitrogen directly from the air.
6. Nitrogen in some farm produce.
7. Soy beans, showing effect of inoculation.
8. Collecting soil from sweet clover field for inoculating.
9. Liquid cultures of legume bacteria.
10. Legumes and profitable farming.
11. Corn following alfalfa. Two years in alfalfa, on the right, one year, on the left.
12. Standard rotation for the timothy-clover area.
13. A good field of timothy and clover hay with a large part clover.
14. Corn, clover, and cows—a practical rotation.
15. An improved rotation for general or live-stock farming.
16. Cover crop of hairy vetch seeded at the last cultivation of the corn.
17. Seeding crimson clover in corn at last cultivation.
18. Feeding value of legumes.
19. Dairy cows on timothy and clover pasture.
20. Turning under red clover for green manure.
21. Field peas as a catch crop following wheat.
22. Cornfield badly in need of a cover crop.
23. Red-clover plant.
24. A good stand of red clover on sandy stump land, Michigan.
25. A successful stand of clover with grain as a nurse crop.
26. Small-seed disk drill.
27. Clover seeded after wheat harvest on well-prepared seed bed.
28. Clover hay cures best in cock.
29. Steers on clover pasture.
30. A fine stand of alsike clover.
31. A field of soy beans.
32. Soy beans are well adapted to cultivation in rows.
33. Soy beans for seed, Peking variety.
34. A convenient rack for curing soy-bean hay.
35. A good field of Whippoorwill cowpeas.
36. A good field of alfalfa.
37. Limed and unlimed fields.
38. The pulverizer is a valuable tool in preparing a seed bed.

No. of view.

39. Alfalfa hay in process of curing.

40. *Melilotus alba* showing ability to succeed in practically pure gravel bed alongside road.

41. Stand of self-seeded Melilotus from original seeding nine years previous, on typical run-down field.

42. Mowing white sweet clover for hay. Not yet in bloom.

43. Hairy vetch and rye. The rye holds the vetch well off the ground.

44. Crimson clover, showing the most advanced stage of ripening which is allowable to use for hay.

45. Field peas and oats in prime condition for hay.

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